Bridge Deck Joints and Deck Joint Seals

Introduction

Although often thought of as static, highway structures are continually in a state of motion. Expansion and contraction caused by temperature changes, shortening and creep caused by prestressing, deflections caused by live loads, and longitudinal forces caused by vehicular traffic all combine to produce nearly continuous motion in highway bridges. Such movements are deceptively slow; however, the associated forces are tremendous.[1]

The most common method of accommodating movement and associated forces is the deck joint. Deck joints fall into two broad categories: open joints and sealed joints. In the past Caltrans has used both open and a variety of sealed joints with varying degrees of success.

The design and performance of a structure's deck joints have a significant impact on bearing performance and future maintenance of the structure. Failed deck joints have caused extensive damage to bearings, abutment backwalls and diaphragms in the past. Thus, the lack of attention to design and construction details or trying to minimize the initial cost of the joint may result in costly future maintenance and repairs.

Supersedes Memo to Designers 7-10 dated April 1990

General Policy

This memo establishes a general policy to coordinate all aspects of deck joints, and deck joint seals.

Except in rare circumstances, Division of Structures policy is to seal all bridge joints. There may be locations where it is appropriate to design an open joint or finger joint. The Joint Seals and Bearings Technical Specialist will offer advice, and will refer the designer to "As-Built" plans for details of such installations when possible.

The type of seal to be used generally depends on the structure movement rating (MR) as follows:

Movement Rating (MR)	Type of Seal
Less than or equal to ½"	Type A Seal (poured sealant)
1" thru 2"	Type B Seal (neoprene compression seal)
2½" thru 4"	Joint Seal Assembly (strip seal)
Greater than 4"	Joint Seal Assembly (modular unit)

Other joint seal systems may be appropriate for special circumstances, such as decks with AC overlays, joint seal replacement contracts with existing oversized "*a*" dimensions, and structures with large skews (skew ≥ 45°). The Joint Seals and Bearing Technical Specialist will offer advice in these cases.

The performance of these seals is contingent upon correct installation, a well detailed set of contract plans (and shop plans where required) and precise specifications. The responsibilities of individuals in the respective functional areas are described below:

Design

1. Determines the MR (Movement Rating) of all bridge expansion joints and prepares the Joint Movements Calculations sheets.

2. Consults with the Joint Seals and Bearings Technical Specialist for special designs on large MR sealed joints during the early design stage.

3. Furnishes to Construction the Joint Movements Calculations forms with the submittal of the Preliminary Report.

4. Furnishes revised Joint Movements Calculations forms for going contracts when requested by Construction.

5. Provides precise details at hinges and abutments to accommodate joint seal assemblies where required. This may include deck overhang details.

6. Reviews and approves joint seal assembly shop plans with the assistance of the Joint Seals and Bearings Technical Specialist and the Structure Representative.

7. Advises Specifications at least 2 months before PS&E when a proprietary seal is needed and furnishes information for their use in obtaining approvals.

Specifications

1. Coordinates with Design on all types of expansion joints.

2. Obtains necessary approvals and price commitments when proprietary seals are needed.

Construction

1. Determines the proper groove width or installation dimensions for the seals and completes the Joint Movements Calculations form.

2. Works with the design project engineer and the Joint Seals and Bearings Technical Specialist in verification and approval of joint seal shop plans.

3. Installs movement recording scribes on all expansion joints.

4. Returns the Joint Movements Calculations forms to the Office of Structure Construction with the Final Report. The office of Structure Construction will forward the documents to the Office of Structure Maintenance and Investigations.

5. Verifies that one set of corrected 22" × 34" prints of joint seal assembly working drawings were submitted by the contractor to the Documents Unit (when joint seal assembly required).

Maintenance

1. Files the Joint Movements Calculations forms, and makes sufficient recordings of each joint to evaluate joint movement or changes in joint movement.
2. Furnishes information to the Joint Seals and Bearings Committee so that problem areas can be evaluated as soon as possible.
3. Updates the Bridge Maintenance Database.

Joint Seals and Bearings Technical Specialist

1. Provides liaison and represents the Department by participating with other agencies, organizations and industry.
2. Keeps aware, through various sources, of state-of-the-art developments, applications, and practice.
3. Reviews, examines, and evaluates systems and proprietary products.
4. Coordinates and works with Design, Construction, Maintenance, and Laboratory personnel to solve problems, initiate research, and reach conclusions.
5. Develops and recommends methods, procedures, policy, and specifications.
6. Revises, updates and interprets standards, specifications, memos, and manuals.
7. Proposes and advocates use of appropriate new applications, methods, and materials.
8. Develops and uses various training methods that help and encourage designers to use new applications, methods, and materials.
9. Is a technical resource assisting, counseling and advising designers, maintenance engineers, construction engineers, and national organizations' committee members.
10. Works with Joint Seals and Bearing Committee to evaluate, develop, and implement Caltrans' policies and procedures.
11. Reviews shop plans and provides consultation to design and construction personnel.

12. Works with AASHTO in developing national criteria.
13. Works with manufacturers to stay abreast of new technology and products.
14. Provides expertise to others preparing standard plans and specifications.

Joint Seals and Bearings Committee

1. Is concerned with the design, installation, and maintenance of joint seals and bearings.
2. Establishes, evaluates, and, if necessary, revises procedures involving expansion joints.
3. Advises Design as to type of joint seal to be used.
4. Provides technical assistance to Construction and Maintenance when requested.
5. Keeps aware, through various sources, of state-of-the-art developments, applications, and practice.
6. Reviews, examines, and evaluates systems and proprietary products.
7. Coordinates and works with Design, Construction, Maintenance, and Laboratory personnel to solve problems, initiate research, and reach conclusions.
8. Develops and recommends methods, procedures, policy, and specifications.
9. Revises, updates, and interprets standards, specifications, memos, and manuals.
10. Proposes and advocates use of appropriate new applications, methods, and materials.
11. Develops and uses various training methods that help and encourage designers to use new applications, methods, and materials.
12. Is a technical resource assisting, counseling and advising designers, maintenance engineers, construction engineers, and national organizations' committee members.

Design Policy

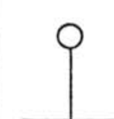
Location of Deck Joints

For most structures, locate deck joints at the abutments and take all the movement there. Excessive column forces in long structures may require the introduction of intermediate hinges. Hinges in CIP concrete structures should be avoided over traffic openings through falsework. Open or finger joints should be avoided over traffic or other facilities (railroads, pedestrians, etc.)

Where possible, limit the movement rating at a hinge to 4". In certain cases, delaying the seal installation, thereby eliminating some of the long term prestress shortening, has been successful. Above this value the joint details become complex and the maintenance effort expands. However, seismic design often favors a reduction in the number of hinges with a corresponding increase in movement at each joint. Joint seals to MR = 12" and beyond have been installed in such cases.

Points of No Movement

Points of no movement may be calculated by the approximate method. This method is shown in Example No. 1 (Attachment 1) and is accurate enough for most cases. For structures with seat type abutments, Bridge Design System reports the point of no movement for each frame. Diaphragm type abutments on spread footings should be checked for sliding when the stiffness of the diaphragm is used to calculate the points of no movement. Use the following stiffness values to calculate the resistance of diaphragm type abutments on piles.

Properties/Piles					
Pile Type	I (ft^4)	E (psi)	Equivalent Length	End Condition	Lateral Resistance k/in Deflection
Class 45 or 70 16" CIDH HP 10×57	0.115	4.0×10^6	5.50'		100 k/pile
HP 10×42	0.080	4.0×10^6	5.35'		75 k/pile

For long curved freeway to freeway connectors, the movement at the abutments and hinges should be calculated using a three-dimensional STRUDL model for the structure.

Movement Rating (MR) Calculations

The Joint Movements Calculations form (Form DS-D-0129) is to be used to calculate the MR for all bridge expansion joints. This sheet is to be placed in the preliminary report for forwarding to Construction, (RE pending file). Example No. 2 (Attachment 2) illustrates the necessary information to be provided by Design. Joint movement calculations may be reviewed with the "Maximum Contributory Structure Length" chart (Attachment 3).

The MR is equal to the total anticipated movement from widest to narrowest opening of a joint. This is equal to the total thermal movement plus any anticipated shortening. The factors used to calculate the thermal movement are those found in the *Bridge Design Specifications.* The temperature range is the extreme ambient temperature range of the area which is given in the preliminary report. Since the structure's temperature range is fairly close to the ambient range, no adjustment will be made to the ambient range.[2] The factors used to calculate the anticipated shortening are about one-half the total expected creep and shrinkage. The reason for using the 50% factor is that approximately one-half of total anticipated shortening should be out of the structure at the time the joint groove widths are determined (approximately 11 weeks). These values should be adjusted if the joint installation will be delayed or accelerated significantly. See the attached Prestress Shortening Chart (Attachment 4).

Type of Structure	**Coefficient of Expansion** movement/unit length/degree Fahrenheit	**Anticipated Shortening** inches/100 feet of contributory length
Steel	0.0000065	0.00"
Concrete (conventionally reinforced)	0.0000060	0.06"
Concrete (pretensioned)	0.0000060	0.12"
Concrete (post tensioned)	0.0000060	0.63"

Note that post tensioned concrete structures are expected to shorten about 0.63 inch/100 feet due to stressing after the joint groove widths are determined. The total long-term shortening is anticipated to be 1.20 inch/100 feet. The difference between the long-term shortening and the initial shortening is equal to 0.63 inch/100 feet. This is the value shown on the Joint Movements Calculations form as "Anticipated Shortening for Post Tensioned Concrete Structures."

Many variables affect the actual movement in an expansion joint. Some of these are:

a. The actual point of no movement may differ from the calculated point of no movement.

b. The actual shortening may differ from the estimated shortening. Shallow CIP P/S structures (depth/span < 0.04) may experience prestress shortening > 1.20 inch/100 feet.

c. The actual minimum and maximum structure temperatures may differ from the extremes listed in the preliminary report.

d. The modulus of elasticity (E_c) may vary from the value used in the model.

The above listed variables, plus the fact that the Movement Rating test method does not provide a dependable safety factor, explains the need for making conservative assumptions in design; therefore, the calculated MR's shall be rounded up to the nearest half inch. On prestressed structures increase the movement rating 25 percent when the MR is greater than 4 inches. The increase is handled in the Joint Movements Calculations form. Note that one of the primary reasons for bridge joint failure is unanticipated structure movement.[1]

The MR of all joints must be shown on the plans. Examples of the correct notation on the plans are as follows:

Type	Notation	Standard Plan
Open Joint	Open Joint (MR = 2"*)	—
Type A	Joint Seal (MR = ½")	B6-21
Type B	Joint Seal (MR = 1½"*)	B6-21
Joint Seal Assembly	Joint Seal Assembly (MR = 3"*)	B6-21
Longitudinal Joint	Joint Seal (Type AL)	B6-21

*Calculated MR for the joint.

Types of Joints

Open Joints

In most cases an open joint is not appropriate. Where it has been determined that an open joint is acceptable, consideration should be given to the passage of water and debris through the joint. Open joint designs should include gallery space for maintenance personnel to inspect and clean. Connections to a drainage system should also be included. There are no standard details. The Joint Seals and Bearings Committee and Structure Maintenance must approve.

Sealed Joints (MR = 2" maximum)

Sealed joints in this movement range should be noted on the plans and referenced to Standard Plan B6-21. No further information is necessary on the plans. The *Standard Specifications* specify that a Type A pourable seal shall be used for an MR of ½" and that a Type B compression seal be used for MR*'s* of 1", 1½" and 2". See Attachment 5 for dimensions for the Type B compression seals, for the maximum groove width *W1*, and for the saw cut depth.

Joint Seal Assemblies (MR ≥ 2½")

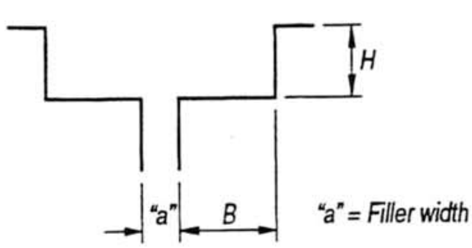
Joint seal assemblies (MR = 2½" – 4") require use of Bridge Standard Detail Sheet XS-12-59. Complete the table on this sheet, including joint location, MR, skew, "*a*" dimension, and insert into the contract plans. The *Standard Special Provisions* also allow the use of alternative joint seal assemblies, which are approved after submittal of shop plans. Refer to Attachment 6 for typical alternative joint seal assembly details (MR = 2½" – 4").

Joint Seal Assemblies (MR > 4") require a modular assembly with intermediate supports. Standard devices are available for movement ratings starting at 6 inches up through 24 inches in 3-inch increments.[1] Hence, a joint with a 6½ inch movement rating will require a 9-inch joint seal assembly. The movement rating of the assembly is measured normal to the longitudinal axis of the assembly. Therefore, skewed structures may require a larger assembly, refer to Example No. 3, Attachment 7. The *Standard Special Provisions* describe detailed specifications. The selected seal is approved after submittal of the shop plans. Refer to Attachment 8 for typical modular joint seal assembly details.

In both cases a blockout for the assembly is required at the joint. The assembly itself is cast in a second concrete pour (closure pour) after any deck grinding has occurred. The designer should design the hinge to carry $DL + LL + I$ without the capacity provided by the blockout for the joint seal assembly. The reason for this is that heavy construction equipment is likely to travel across the joint prior to the closure pour and a future joint replacement could require removal of the section. Therefore, main reinforcing bars should be detailed outside the blockout area to maintain structural capacity prior to pouring the closure pour.

Recommended blockout dimensions are tabulated below:

Movement Rating	Blockout Width (*B*)	Depth (*H*)
2½" to 4"	1'-0"	10"
6" (2 cells)	1'-6"	14"
9" (3 cells)	2'-0"	15"
12" (4 cells)	2'-6"	16"
15" (5 cells)	2'-6"	16"



Blockout Dimensions

Although some modular joint seal assemblies can be installed in 12-inch deep blockouts, it often results in construction difficulties. Shallow blockouts often leave limited vertical clearance between the assembly support boxes and the bottom of the blockout. Hence, the blockout closure pour may not be completed monolithically.

The abutment or hinge sheets should detail adequate reinforcement to engage the assembly, while keeping main reinforcement and reinforcing bars No. 6 and larger out of the blockout area to ensure constructibility. Conflicts between main reinforcing steel and joint seal assemblies must be resolved by the Designer, not the Construction Engineer or manufacturer. The joint seal shop plans should note any required rearrangement of this reinforcement. Hence, timely submittal and review of shop drawings is essential to avoid construction delays and problems. In addition, Joint Seal Assemblies MR > 4" require that a special overhang detail be included in the plans. Use Bridge Standard Detail Sheets XS-12-78 and XS-12-79. Abutment backwalls may have to be modified to accept the large blockout as well. In short, blockouts must be compatible with bridge details at hinges, abutments, barriers, sidewalks, and approach slabs.

The Joint Seals and Bearings Technical Specialist has details of the various assemblies that have been installed, and is able to assist in system verification as requested.

The shop plan review is a joint effort between the Project Engineer, the Structure Representative and the Joint Seals and Bearings Technical Specialist. The design project engineer should check any modifications affecting the design, e.g. blockout dimensions, reinforcement rearrangement, interference with prestress anchorage, etc. For complex joints (high skew, varying deck width) the Project Engineer will assist the Structure Representative by verifying the shop plan dimensions (joint length, upturn in barrier, etc.). The Structure Representative will verify that the assembly meets the specifications and check the fabrication dimensions. The Technical Specialist will verify that the assembly is structurally adequate and is an approved system. The final shop drawing approval will be made by the project engineer.

Longitudinal Joints

When longitudinal joints cannot be avoided, specify "Joint Seal (Type AL)", and reference Standard Plan B6-21.

Widening or phase constructed superstructures are typically attached positively by closure pours. (See Memo to Designers 9-3.)

Finger Joints

If finger joints are considered, confer with the Joint Seals and Bearings Technical Specialist. Finger joints are discouraged for new work.

Expansion Joint Fillers (Sealed Joints)

For MR ≤ 2", the expansion joint width is sized by the filler width "*a*" as shown on Standard Plan B6-21. Do not dimension on the plans.

For MR > 2", the thickness of expanded polystyrene shall be shown on the plans and calculated as follows:

Season	**Filler Width "*a*"**
Summer	"*a*" = ½ (MR less anticipated shortening)
Spring and Fall	"*a*" = ¾ (MR less anticipated shortening)
Winter	"*a*" = MR less anticipated shortening

Where "*a*" = thickness of expanded polystyrene.

The anticipated shortening should be calculated by the factors shown on the Joint Movements Calculations form. No reference to Standard Plan B6-21 should be shown on plans for MR > 2".

Expansion Dams

Refer to Bridge Design Details, page 8-45 for details to construct expansion dams when overlays are required on new structures with expansion joints.

Snow Plow Deflectors

Snow plow deflectors may be required to protect joints and plowing equipment on structures that are regularly cleared of snow. Skewed structures that match the plow skew (approximately 37°) are especially vulnerable to damage. Consult with the Joint Seals and Bearings Technical Specialist and Maintenance for suggestions and details on how to protect joints.

Skewed Joints

Skewed joints place extra demands on joint seals. As a joint opens and closes on a skewed structure, the joint seal shears longitudinally along the joint. There is no practical way to reduce this shear stress other than to limit the skew. On joint seal assemblies, skew generated stresses are partially accounted for by increasing the size of the assembly, refer to Example No. 3.

To facilitate construction, joint seals (all types) should be detailed perpendicular to the barrier when the joint skew exceeds 20 degrees.

Waterstop

The waterstop, in addition to resisting leaking, provides a membrane that stops silt, sand, concrete chippings, etc., from falling into a joint below an easily accessible level. Debris is especially a problem during construction before a joint is sealed and even after construction if there is a joint seal failure. Waterstop should be specified at all sealed joints at hinges and seat type abutments (without approach slabs) where Standard Plan B6-21 is used.

Waterstop, when required, should be shown on the plans and referenced to Standard Plan B0-3.

Do not use waterstop with open joints, longitudinal expansion joints, and joints with a MR greater than 2". Use a neoprene strip on joints with MR's greater than 2 inches.

Quantity Estimate

Estimate the linear feet of each MR joint seal called for on the plans. Waterstop is a separate item and should be estimated in linear feet.

As-Built Plans

Approved/corrected joint seal assembly working drawings are submitted by the Contractor to the Documents Unit and incorporated into the As-Built plans.

Bridge Deck Joint Rehabilitation Projects

Details and procedure specific to rehabilitation projects are discussed in Attachment 9.

Other Considerations

It is the designer's responsibility to check the movement capability of all details shown on the plans. This check includes items such as hinge details, elastomeric pads, abutment diaphragms on piles or spread footings, earthquake restrainers and any other details which may be affected by too much movement. In all cases, the movement capacity of these items should be greater than the calculated movement, or as recommended by other Memos to Designers.

References/Footnotes

1. "Bridge Deck Joints," NCHRP Report 141, September 1989. Transportation Research Board.

2. "Annual Movement Study of Bridge Deck Expansion Joints Final Report," prepared by Carl F. Stewart, June 1969. Business and Transportation Agency, Department of Public Works, Division of Highways, Bridge Department.

3. "Draft LRFD Bridge Design Specifications and Commentary," NCHRP Report 12-33, March 1993. Modjeski and Masters, Inc., Consulting Engineers.

Floyd L. Mellon

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Shannon H. Post

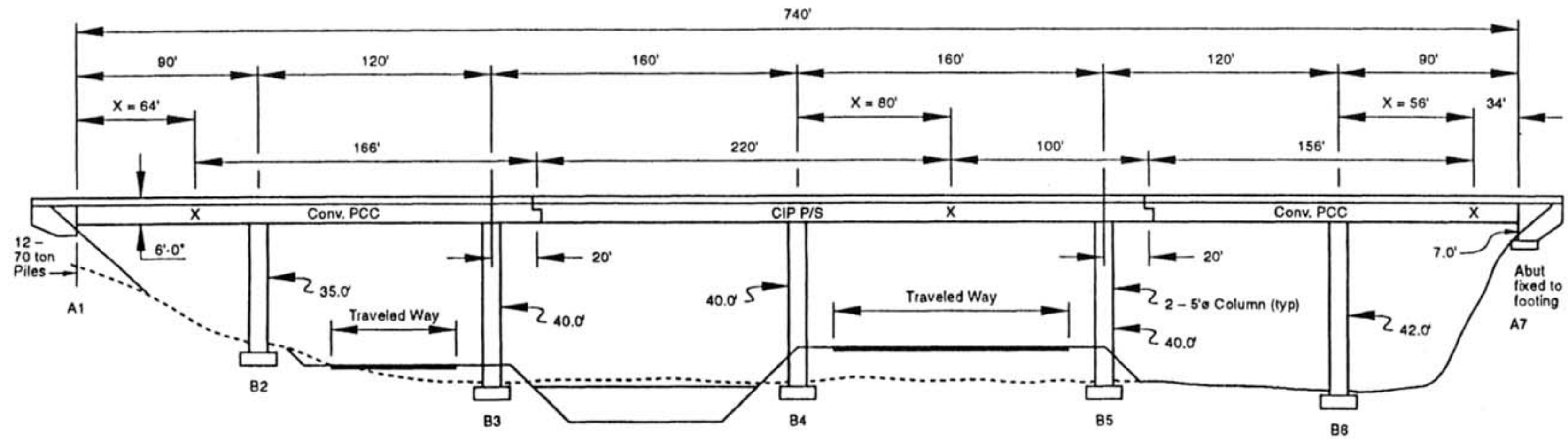
Shannon H. Post

RL:jgf
Attachments

Attachment 1

Example No. 1

Calculation of Points of No Movement



	A1		B2		B3			B4		B5			B6		A7		
I (Ft)[4]	1.38		61.36		61.36			61.36		61.36			61.36		102		
L (Ft)	5.50		35.0		40.0		Sum	40.0		40.0		Sum	42.0		7.0		Sum
P (kips) @ 1" side sway	1200	+	618	+	415	=	2,233	415	+	415	=	830	359	Will slide +	600	=	959
D (distance from 1st member of frame)	0		90		210			0		160			0		90		
P × D / 100	0	+	556	+	872	=	1,428	0	+	664	=	664	0	+	540	=	540
$X = \frac{\Sigma(P \times D)/100}{\Sigma P}(100) = \frac{1,428}{2,233}(100) = \underline{64'}$								$\frac{664}{830}(100) = \underline{80'}$					$\frac{540}{959}(100) = \underline{56'}$				

Notes:
- Width of Structure = 78'
- Diameter of Column = 5'-0"
- K/Pile @ 1" deflection = 100 kips
- Point of No Movement = X
- Refer to Properties/Piles Table

Assumptions:
1. Super str. inf. rigid
2. Columns fixed top and bottom
3. Abutment footing will slide @ a force equal to D.W.
4. E (piles) = 4×10^6 psi
   E (columns) = 3×10^6 psi

Fixed/Fixed Condition

$$P\text{ (Col.)} = 12EI\frac{\Delta}{L^3}$$

$$@\ 1"\text{ defl.} = \frac{432\,I}{\left(\frac{L}{10}\right)^3}$$

Pinned/Fixed Condition

$$P\text{ (Col.)} = 3EI\frac{\Delta}{L^3}$$

$$@\ 1"\text{ defl.} = \frac{108\,I}{\left(\frac{L}{10}\right)^3}$$

D.W. Abut 7 = 600 k (assume linear up to 1" deflection)

$$I\text{ (abut)} = \frac{78}{12}(2.5)^3 = 102$$

Caltrans

Attachment 2

Example No. 2

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

JOINT MOVEMENTS CALCULATIONS [a]

DSD-D-0129 (REV. 5/93)

EA	DISTRICT	COUNTY	ROUTE	PM	BRIDGE NAME AND NUMBER
03-000000	03	Sac	5	0.2/2.4	Dry Creek O.C. 29-000

TYPE STRUCTURE	TYPE ABUTMENT	TYPE EXPANSION (2" elasto pads, etc)
Reinf. Conc. Box and CIP P/S	A1 - 70T Piles/A7 - Spd. Ftg.	Bent 3 - Steel Hangers/Bent 5 - 2 1/2" Pads

① TEMPERATURE EXTREMES (from Preliminary Report)

			② THERMAL MOVEMENT (inches/100 feet)		ANTICIPATED SHORTENING (inches/100 feet)		③ MOVEMENT FACTOR (inches/100 feet)
Maximum 110 °F	Steel	Range (___ °F) (0.0000065 × 1,200) =	___ . ___	+	0.00	=	___ . ___
− Minimum 23 °F	Concrete (*Conventional*)	Range (87 °F) (0.0000060 × 1,200) =	0 . 63	+	0.06	=	0 . 69
	Concrete (*Pretensioned*)	Range (___ °F) (0.0000060 × 1,200) =	___ . ___	+	0.12 [g]	=	___ . ___
= Range 87 °F	Concrete (*Post Tensioned*)	Range (87 °F) (0.0000060 × 1,200) =	0 . 63	+	0.63 [g]	=	1 . 26

ITEM ① DESIGNER	DATE	ITEM ② CHECKED BY	DATE

To be filled in by Office of Structures Design [b]

To be filled in by SR [c]: W. T. Trustworthy Date: 2/21/94

Location	Skew (degrees) Do not use in calculation	④ Contributing Length (feet)	Calculated Movement (inches) ③ × ④ / 100	M.R. (inches) (Round up to 1/2")	Seal Type A, B (Others) or Open Joint	Seal Width Limits [d]: Catalog Number	Seal Width Limits [d]: W_1 (inches) Maximum	Seal Width Limits [d]: ⑤ W_2 (inches) Min. @ Max. Temperature	Groove (saw cut) Width or Installation Width [e]: Structure Temperature (°F) [f]	Groove (saw cut) Width or Installation Width [e]: ⑥ Adjust from Maximum Temp. (inches) ▲ᶜ/① × ② × ④/100	Groove (saw cut) Width or Installation Width [e]: Width at Temp. Listed (inches) w = ⑤ + ⑥
Abut. 1 (Conv.)	0	64	0.44	1/2	A						
Span 3 Hinge (Conv.)	0	166	1.15	–							
Span 3 Hinge (CIP P/S)	0	220	2.77	–							
Span 3 Hinge Total	0	386	3.92	4	Joint Seal Assembly						
Span 5 Hinge (CIP P/S)	0	100	1.26	–							
Span 5 Hinge (Conv.)	0	156	1.08	–							
Span 5 Hinge Total	0	256	2.34	2 1/2	Joint Seal Assembly						
Abut 7 (Conv.)	0	34	0.23	1/2	A						

a Project Designer: Send to RE or SR with Preliminary Report.
b Show line drawing of structure on reverse side; show points of no movement and contributory lengths. Retain copy for design calculations file.
c RE or SR: Complete and return to Structure Construction with final report.
d Type B information from TransLab reports.
e Groove width adjustment based on ▲ᶜ = (maximum temperature extreme) minus (superstructure temperature).
f Measure superstructure temperature by placing bulb of concrete thermometer ± 6 inches into expansion joint.
g When MR is greater than 4 inches, increase anticipated shortening 25%.

Attachment 3

To be used to review joint movement calculations

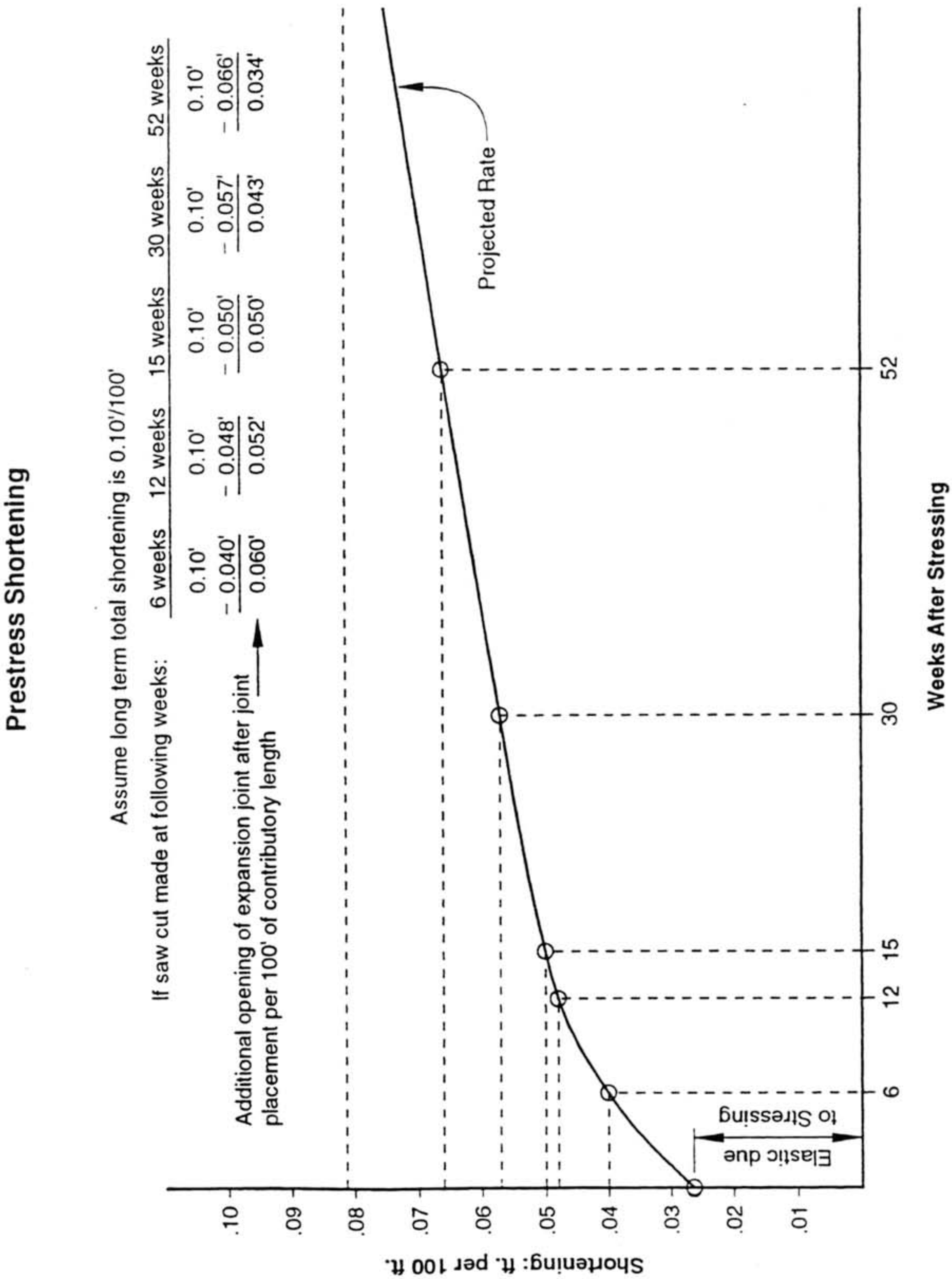
Sample Calculation: Post tensioned, 100°, MR = 3"
Contributory Length = (3) / [100° (0.0000060 × 1,200) + 0.63] / 100' = 222' say 220'

TOTAL JOINT MOVEMENT (MR) (Inches)	MAXIMUM CONTRIBUTORY STRUCTURE LENGTH											
	80° RANGE				100° RANGE				120° RANGE			
	Steel	Reinforced Concrete	Pretension Concrete	Post Tension Concrete	Steel	Reinforced Concrete	Pretension Concrete	Post Tension Concrete	Steel	Reinforced Concrete	Pretension Concrete	Post Tension Concrete
½"	80.	80.	70.	40.	65.	65.	60.	40.	55.	55.	50.	35.
1"	160.	160.	145.	85.	130.	130.	120.	75.	105.	110.	100.	65.
1½"	240.	235.	215.	125.	195.	190.	180.	110.	160.	160.	150.	100.
2"	320.	315.	285.	165.	255.	255.	240.	150.	215.	215.	200.	135.
2½"	400.	395.	360.	210.	320.	320.	300.	185.	265.	270.	255.	170.
3"	480.	470.	430.	250.	385.	385.	360.	220.	320.	325.	305.	200.
3½"	560.	550.	505.	290.	450.	450.	415.	260.	375.	380.	355.	235.
4"	640.	630.	575.	330.	515.	515.	475.	300.	425.	430.	405.	270.

FACTORS USED		
Type of Structure	Coefficient of Expansion	Anticipated Shortening (in./100 ft.)
Steel	0.0000065	0.00
Concrete (Conventional)	0.0000060	0.06
Concrete (Pretensioned)	0.0000060	0.12
Concrete (Post Tensioned)	0.0000060	0.63*

*Note: Anticipated shortening and remaining approximately 11 weeks after stressing.

Attachment 4



Attachment 5

Approximate Properties for Preformed Elastomeric Joint Seals Type B
Manufacturer's Nominal Properties for Design Data Only

(See Note 4)

Catalog Number (See Note 1)	Uncompressed Size (See Note 3) W_o	D_o	Approximate MR (See Note 2)	W_1 Maximum Groove Width	W_2 Minimum Groove Width	Recommended Saw Cut Depth (See Note 4)
Brown H-2502	2.50"	2.50"	1.00"	2.13"	1.13"	4.00"
Brown H-3000	3.00"	3.25"	1.00"	2.55"	1.55"	5.00"
Brown H-3500	3.50"	3.75"	1.50"	2.98"	1.48"	5.85"
Brown H-4000	4.00"	4.06"	1.50"	3.40"	1.90"	6.00"
Brown H-5000	5.00"	5.13"	2.00"	4.25"	2.25'	7.75"
Brown H-6000*	6.00"	5.50"	2.50"	5.10'	2.60"	9.25"
W.B. WA-250**	2.50"	2.75"	1.00"	2.13"	1.13"	3.56"
W.B. WA-300	3.00"	3.38"	1.00"	2.55"	1.55"	4.31"
W.B. WA-350	3.50"	3.50"	1.00"	2.98"	1.98"	4.44"
W.B. WA-400	4.00"	4.38"	1.50"	3.40"	1.90"	5.00"
W.B. WA-500	5.00"	5.00"	2.00"	4.25"	2.25"	5.94"
W.B. WA-600*	6.00"	6.00"	2.50"	5.10"	2.60"	7.75"

*Rehabilitation Projects only **W.B. – Watson Bowman

Notes:

1. Brand names other than those listed may be available.
2. The actual Movement Rating equals ($W_1 - W_2$).

   W_1 shall be the smaller of the values determined as follows:

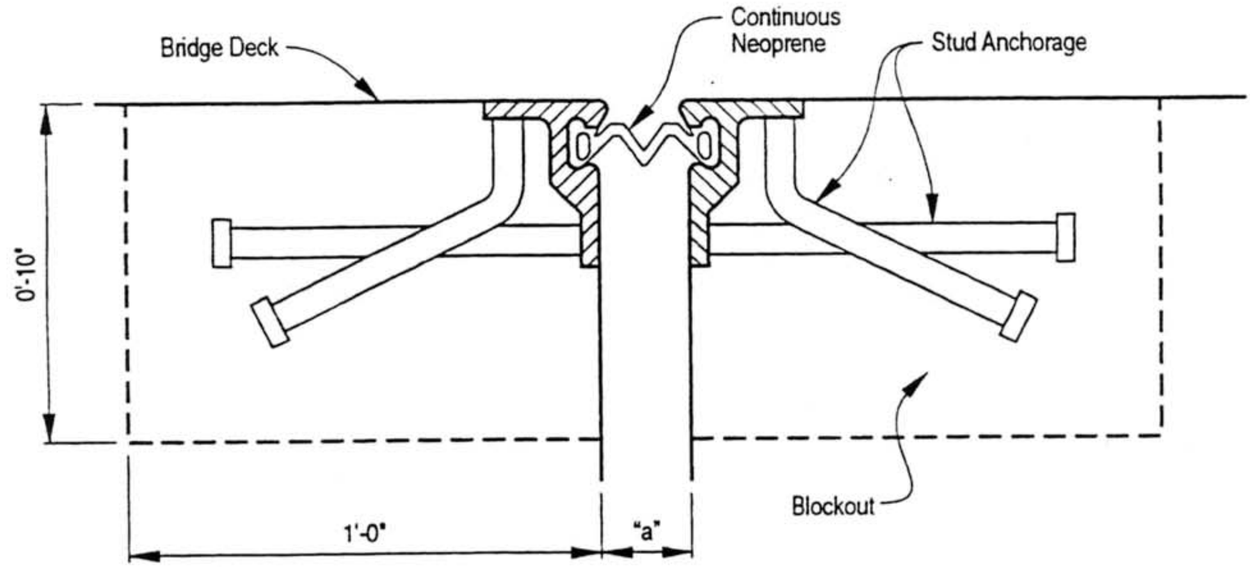
   A. 0.85 times the manufacturer's designated minimum uncompressed width of the seal (W_0).

   B. The width of seal on the third successive test cycle of the pressure-deflection test, when compressed to an average pressure of 3.0 pounds per square inch.

   W_2 shall be the width of seal determined on the third successive test cycle of the pressure-deflection test, when compressed to an average pressure of 4 times the pressure measured at the seal width W_1.
3. Data shown may change significantly due to variations in extrusions. Dimensions must be verified in the field.
4. Do not use these properties in lieu of actual test results. These properties are for information only. Actual values for W_1, W_2, and MR are obtained from test results performed by the Transportation Laboratory on the Report of Inspection of Material (Form TL-29).

Attachment 6

Typical Alternate Joint Seal Assembly (MR = 2½ – 4 inches)



Section Thru Expansion Joint

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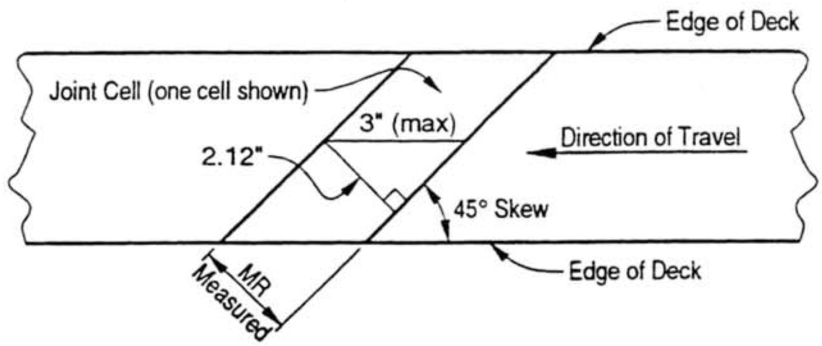
Attachment 7

Example No. 3

Size Blockout Dimensions

Given: CIP P/S Structure
MR = 5½ inches
Skew = 45°

Determine: Blockout width and depth.



The *Standard Special Provisions* specify:

1. The MR is measured normal to longitudinal axis of assembly, disregarding any skew of the deck. This requirement partially accounts for skew generated stresses.

2. The maximum width of unsupported or yielding components or grooves in the roadway surface of the assembly, measured in the direction of vehicular traffic, shall be 3 inches.

Joint Width: MR = 5½" $\frac{5.5}{2.12} = 2.59 \therefore$ 3 cells required (9" MR)

From Blockout Dimension Chart, blockout width = 2'-0".

Joint Depth: From Blockout Dimension Chart, blockout depth = 15".

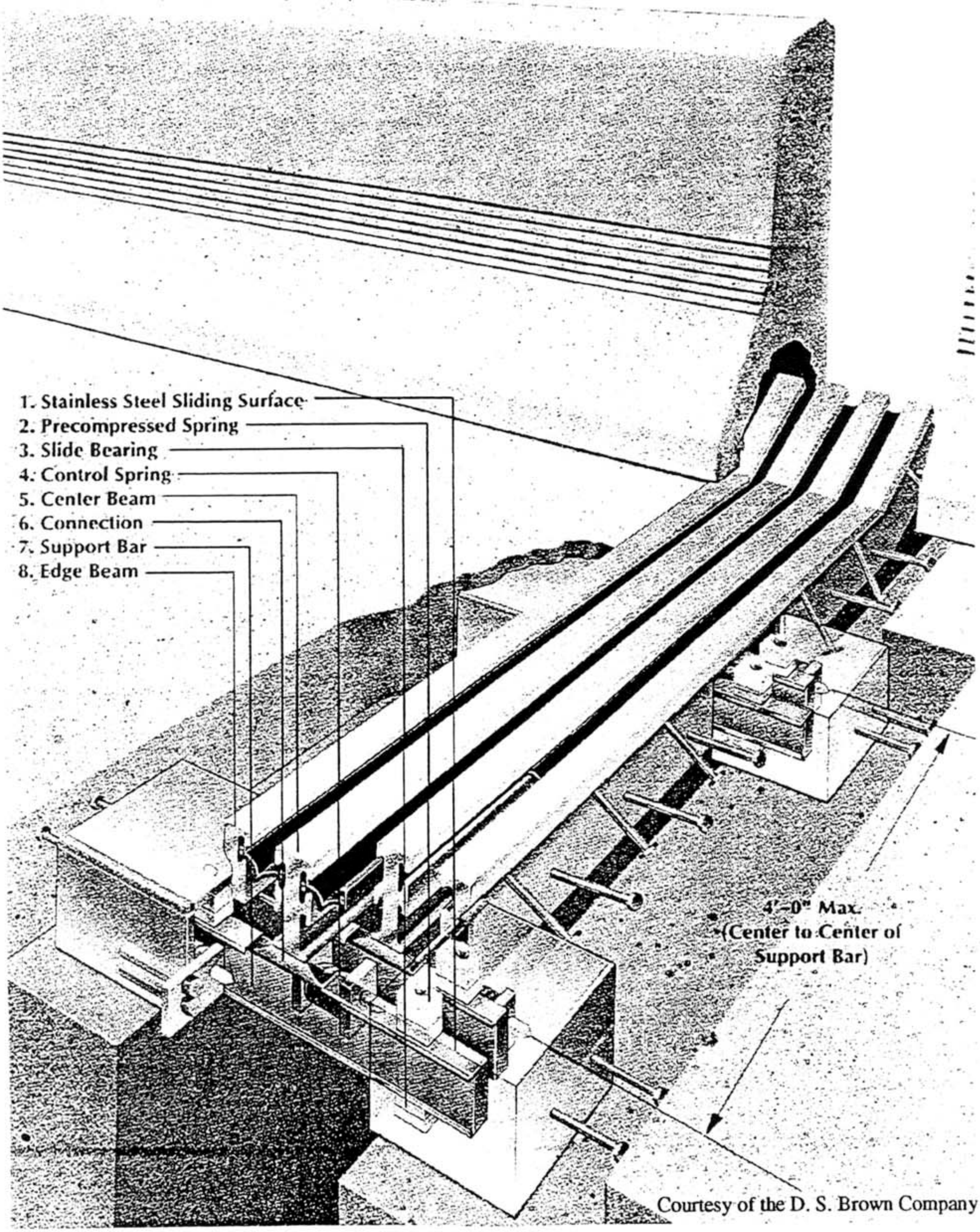
Note: Actual assembly depths for 3 cell (9" MR) joint seal assemblies are as follows:

Watson Bowman ACME	10 13/16"
D. S. Brown Co.	11 23/32"
TechStar Inc.	12¼"

A blockout depth of 15" is desireable for a monolithic closure pour

Attachment 8

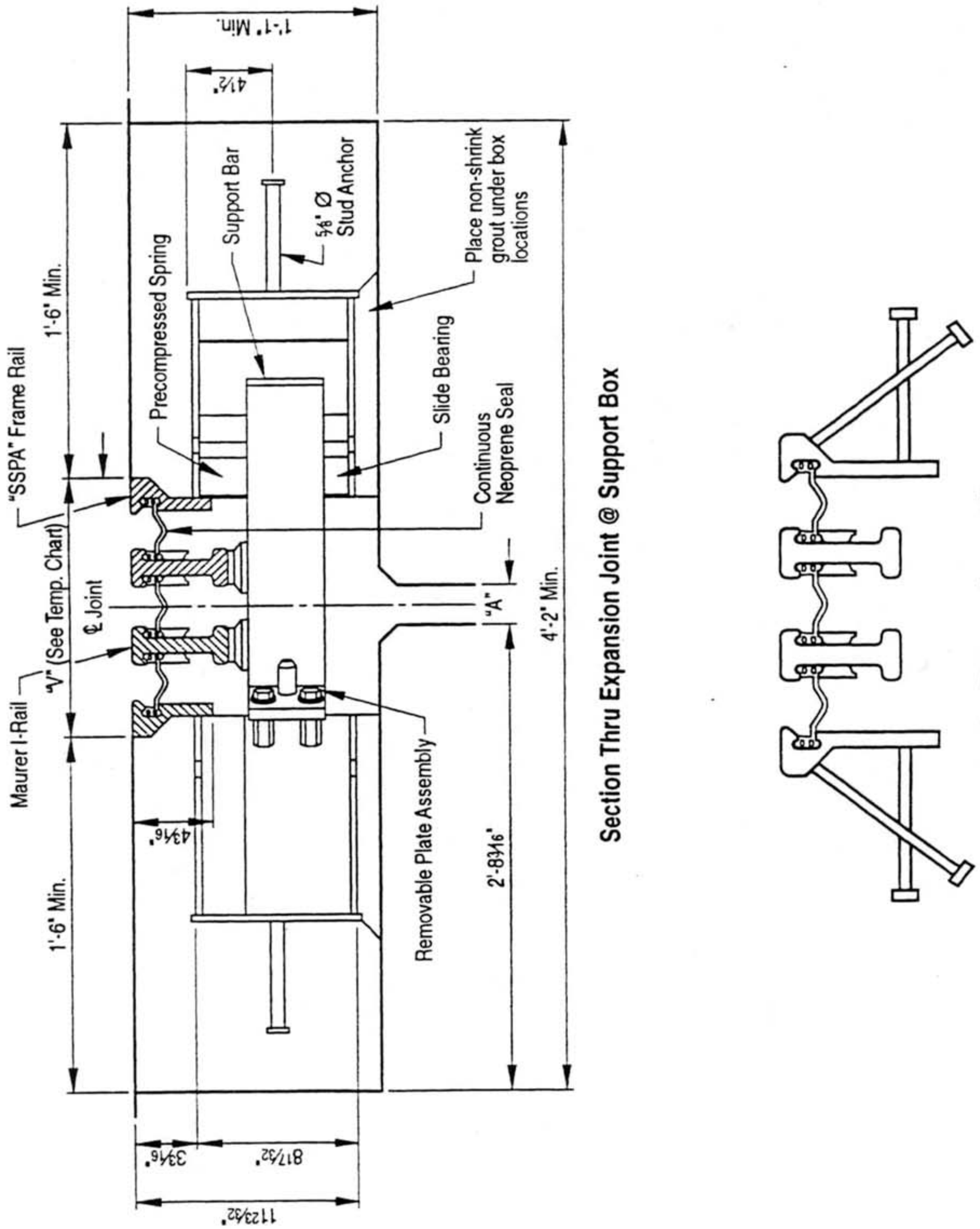
Typical Modular Joint Seal Assembly (MR > 4 inches)
9" MR Joint Shown



Courtesy of the D. S. Brown Company

Attachment 8

Typical Modular Joint Seal Assembly Sections (MR > 4 inches)



Section Thru Expansion Joint @ Support Box

Section Between Support Boxes

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Attachment 9

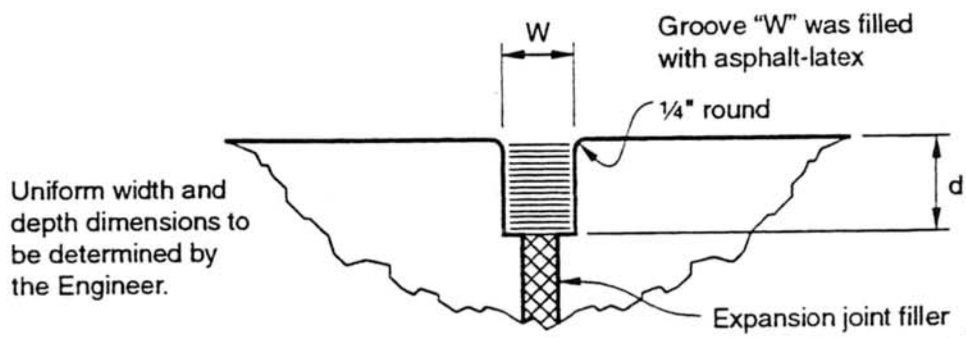
Bridge Deck Joint Rehabilitation Projects

Projects involving the rehabilitation of malfunctioning deck joints in existing structures may qualify for Federal funding under the Resurfacing, Restoring and Rehabilitation (RRR) program if the FHWA's requirements are met. The primary requirement is that the new joint be an improvement over the existing joint. Restoration of a joint or a joint seal to the original condition is not eligible. Refer to the Bridge Books in the Office of Structure Maintenance and Investigations for joint recommendations when modifying or widening an existing bridge.

To assist the District, the Structure Design project engineer should determine if the new joints will be an improvement over the existing joints, and should include a statement in the General Plan transmittal letter that the proposed joint rehabilitation is or is not considered an improvement.

The Structure Design project engineer may determine if the replacement seal is an improvement over the existing seal by using the following guidelines:

A. MR = ½ inch or less: A Type A seal is used to replace existing seals constructed in accordance with Detail L-1 (as shown below) or to replace any other pourable seal placed under contracts completed before 1966.



Detail L-1

B. MR = Over ½" to 2": A Type B seal is used to replace any pourable seal.

Deck joints of questionable nature can be discussed with the Joint Seals and Bearing Technical Specialist.

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Attachment 9

In order for a project involving deck joints to qualify for Federal RRR funding, at least one of the two following conditions must also be met:

1. The project should improve all of the joints for a substantial length of roadway or be part of a pavement overlay project of a substantial length.
2. The cost of the proposed project should be significantly more than the cost of a project that normally would be accomplished by State maintenance forces or handled by an incidental maintenance contract.

The District's project engineer will assess these additional two requirements and determine if Federal funds should be applied for.

In new construction projects joint geometry is readily controllable, being set to accommodate the joint seal.

Rehabilitation projects differ from new construction projects in that the joint seal is selected to fit the existing joint.

Rehabilitation projects with Type B seals require that both the Min W_1, the maximum joint width at minimum temperature (after prestress shortening), and the MR be indicated on the plans. To ensure a correct fit, the W_1 of the joint seal must be greater than the Min W_1 of the joint. To minimize confusion, W_1 of the joint will be referred to as Min W_1.

$$\text{Min } W_1 = W_e + \tfrac{1}{2}" + \left(\frac{T_{str} - T_{min}}{①}\right)(②)\left(\frac{④}{100}\right)$$

Where:

Min W_1	=	maximum joint width in inches
W_e	=	existing joint width in inches
½"	=	minimum practical concrete removal = ¼" each side of joint
T_{str}	=	structure temperature, degree F
T_{min}	=	minimum temperature at structure site—from DS-D-0129
①	=	temperature range at structure site—from DS-D-0129
②	=	thermal movement in inches/100 feet—from DS-D-0129
④	=	contributory length in feet—from DS-D-0129

When available, use the actual physical movement of the joint as indicated by expansion joint scribes, or marks on the barrier rail, to determine the MR and Min W_1.

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Attachment 9

Estimate the required length of joint cleaning as well as the required length of joint seal.

The designer should add supplemental funds to the contract to cover the possibility of repairing joint spalls and cleaning expansion joints below damaged waterstops if they are not included as a repair item.

When AC overlays cross an expansion joint, the designer must determine whether to use expansion dams (*Bridge Design Details*, page 8-45), continuous AC across the joint (joints with a MR of ½" or less), or a proprietary "jointless" system. The Joint Seals and Bearings Technical Specialist and Structure Maintenance should be consulted for advice.